

Watershed Specialist Report Boulder Project

Prepared by: */s/ Kyle E. Wright* Date: *10/24/12*
Kyle E. Wright, Hydrologist
Sequoia National Forest and Giant Sequoia National Monument

Reviewed by: */s/ Terry Kaplan-Henry* Date: *10/25/12*
Terry A. Kaplan-Henry, Forest Hydrologist
Sequoia National Forest and Giant Sequoia National Monument

Purpose and Need

Timing is critical for the Boulder Creek Fuels Restoration (Boulder) Project. In 2010, the Sheep Fire, ignited by lightning, burned through a portion of Monarch Wilderness and Agnew Roadless Area and was stopped on the eastern edge of the Boulder Creek drainage. To take advantage of the natural fuel break created by the Sheep Fire, implementation of the Boulder project would need to start as soon as possible (i.e., by 2013 at the latest).

This project is needed to:

- Reduce excessive fuel loads across the landscape, specifically within the Monarch Wilderness per Manual direction (FSM 2320);
- Re-establish fire to this fire-adapted ecosystem, specifically within several sequoia groves;
- Reduce the risk of loss of old-growth forest habitat to large scale, stand-replacing wildfires; and
- Reduce the risk of loss of cultural resources to wildfires.

The purpose of this project is to:

- Establish or maintain conditions that allow for safe and efficient fire suppression activities;
- Establish conditions that allow for a highly diverse vegetation mosaic of age classes, tree size, and species composition; and
- Protect the other objects of interest where applicable and feasible.

This action responds to the goals and objectives outlined in the Forest Plan as amended, and helps move the project area towards desired conditions described in that plan. It also responds to the goals and objectives in the 2012 Giant Sequoia National Monument Management Plan.

Affected Environment

Watershed Information

There are four 6th field watersheds affected by the Boulder Burn Project. Figure 1 shows a map of the proposed area. Ninety-Five percent of the project is within South Fork Kings River/Lower Boulder watershed (180300100304). The remaining five percent is within South Fork Kings River/ Lightning Creek (180300100302), Tenmile Creek (180300100501), and Upper Boulder Creek (180300100303). Only South Fork King River/ Lower Boulder would be further analyzed for the affected environment. Table 1 displays the stream class, beneficial uses and acres of South Fork King River/ Lower Boulder watershed.

Table 1: Watersheds and Associated Beneficial Uses¹

Watershed Name	Stream Class	Watershed Number	Beneficial Uses (existing)	Acres
South Fork King River/ Lower	I	180300100304	Mun, Rec, Cold, Wild, Spwn, Frsh	24,600
Mun = Municipal, Rec = Contact and/or Non-Contact Recreation, Cold = Coldwater Fishery, Wild = Wildlife Spwn = Fish Spawning, Frsh = Fresh Water				

Beneficial uses are derived from the California Central Valley Regional Water Quality Control Board for Tulare Lake Basin, Chapter 2 (CEPA, 2004).

Boulder Burn Project Map, Hydrology
 Sequoia National Forest, Giant Sequoia National Monument, Hume Lake Ranger District



8/2012
 SQF Hydro, H Kwan

Figure 1: Boulder Project Area Map

CURRENT CONDITIONS

LOWER SOUTH FORK KINGS RIVER WATERSHED (1803001003)

The Lower South Fork of the Kings River Watershed is located on the western slope of the Sierra Nevada Mountain Range. This watershed drains one of three main forks of the Kings River, and is fairly typical of the rugged, partially glaciated river basins of the west side Sierra streams. The watershed is approximately 81,520 acres in size, of which about 57,890 acres are in the Sequoia National Forest. Approximately 23,800 acres are within the Monarch Wilderness, 7,000 acres are within the Jennie Lakes Wilderness, and 400 acres surrounded by National Forest System lands are under private ownership. Kings Canyon National Park makes up about 23,790 acres of this watershed. Approximately 35,470 acres of the watershed within the Sequoia National Forest is within the Monument. This area includes the 9,300-acre Agnew Roadless Area and approximately half of the Monarch Wilderness (estimated 11,900 acres).

Elevation ranges from about 4,000 to 9,000 feet. The watershed is comprised of granite bedrock, which intruded pre-existing ocean floor sediments, which now form roof pendants. Rock types are marble and meta-volcanic and sedimentary. About one-quarter of the watershed has been glaciated, and the remaining three quarters was formed from stream or fluvial processes. Just east of the confluence of the South Fork Kings River and Grizzly Creek, glacial features terminate. The South Fork of the Kings River flows in a rugged river gorge beyond this point. The drainage is characterized by steep, bedrock boulder-dominated river gorges below Grizzly Falls and the wider, flatter uplands above this confluence. Uplands are steep in sections near the watershed divide and exhibit evidence of glacial polish in the headwaters.

Riparian vegetation consists of stringers of willows and aspen along creeks or meadow edges. Vegetation has good vigor and density and meadow species are flooded for about one month each spring during snow melt. Steep bedrock and boulder channels cannot grow lush riparian vegetation along their limited floodplain. This type of riparian ecotype makes up about one-third of the watershed streams.

U.S. Geological Service (USGS) stream gages for the watershed have a 22-year period of record for the Lower South Fork of the Kings River near Hume, California between 1922 and 1957, and a 6-year period of record at Cedar Grove between 1951 and 1956. Measured peak flows from these stations range from 1042 to 2097 cfs and minimum flow from 378 to 409 cfs. Duration of minimum flow is estimated at 22 days and occurs in the month of October. The peak flow in 1952 and minimum flow in 1924 correspond to USGS stream gage readings from other rivers in the vicinity.

Historical logging in the late 1800s impacted this watershed. Much of the watershed was owned by the Hume-Bennett Lumber, Sanger Lumber, and the Kings River Lumber companies. The giant sequoias were logged heavily at this time, and overall impacts to this watershed from

these activities are difficult to quantify. Road decommissioning occurred in this watershed in 1999. Roads 13S23D, 13S23E, 13S23F, 13S28 and 13S53A were removed from the Forest Road system. Roads were blocked-off and most of the culverts and drainage was removed. The road surface was considered to regenerate naturally. Roads 13S23E, 13S23F, and 13S53A were redesigned for non-motorized recreation use. Current condition of the natural recovery of these sites is unknown however due to the lack of use it is assumed that these sites have stabilized. These roads would be evaluated post project to determine resource condition.

Lower South Fork Kings River watershed is separated into six basins: South Fork Kings River, Horse Corral Creek, Upper Boulder Creek, Big Meadow Creek, Little Boulder Creek, and Lower Boulder Creek. The two described in detail are Boulder Creek basin (2E) and Little Boulder Creek (2F). Table 2 shows which watershed will be further described. Portions of the Buck Rock and Horse Corral grazing allotments lie within this watershed.

The South Fork Kings River drains approximately 13.25 linear miles of perennial streams and meadows. Included are: South Fork Kings River, which has not been surveyed, Lightning Creek, Lockwood Creek, Redwood Creek, Windy Gulch, several unnamed tributaries to Lightning Creek, of which one has been surveyed, an unnamed tributary to the South Fork Kings River, Summit Meadow, and Deer Meadow. Description of Riparian Ecotypes after Kaplan-Henry, 2000 is used to help describe riparian characteristics. A summary of these ecotypes may be found in Appendix A.

Table 2: Watershed Basins and 7th Field Watersheds

Watershed Basins	7 th Field Watershed Basins
2E: Boulder Creek Basin	<ul style="list-style-type: none"> • 2E-D: Kennedy Meadows Creek, and Unnamed Tributary to Boulder Creek • 2E-E: Little Boulder Creek, Unnamed Tributary to Little Boulder Creek, and Buck Rock Creek
2F: Lower Boulder Creek Basin	<ul style="list-style-type: none"> • 2F-B: Redwood Creek • 2F-C: Lockwood Creek • 2F-D: Windy Gulch

Boulder Creek Basin (2E)

Boulder Creek Basin encompasses approximately 5,250 acres that drain approximately 7.5 linear miles of perennial streams into Boulder Creek. Included are: Little Boulder Creek, Buck Rock Creek, an unnamed tributary to Little Boulder Creek, an unnamed tributary to Boulder Creek (Kennedy Meadow Creek), Burton Meadow, and Kennedy Meadow. The entire area drains the Buck Rock grazing allotment.

Unnamed Tributary to Boulder Creek (2E-D) Kennedy Meadows Creek

Kennedy Meadows Creek is a Class III stream with headwaters located near Kennedy Meadows.

There are no known fisheries in this tributary. The stream encompasses approximately 2 linear miles, which drain into Boulder Creek. Steep gradient Naturally-Stable riparian ecotype dominates the channel which is comprised of bedrock and boulders over approximately 50 percent of its length. The uppermost portion of the drainage is a Naturally-Unstable riparian ecotype associated with steep-gradient, fine-grained, unstable landforms.

Little Boulder Creek (2E-E)

Little Boulder Creek is a Class II stream and flows for approximately 2.75 linear miles until it confluences downstream with Boulder Creek. The channel is a known fishery approximately 1.75 linear miles below the confluence of Little Boulder Creek and Buck Rock Creek.

Approximately 70% of Little Boulder Creek has characteristics of a Naturally-Stable riparian ecotype. The channel has a steep to moderate gradient with a bedrock boulder substrate. The remaining portion of the drainage meets characteristics of a Naturally-Unstable riparian ecotype associated with unstable landforms resulting in noticeable bank cutting and log jams creating erosive cross currents. One linear mile upstream from confluence of Boulder Creek grazing was evident in an area of the stream with raw banks nearly 4 to 10 feet high. Roads in the upper part of the watershed are associated with sedimentation and concentrated flow. This site was not evaluated pre project and would be monitored for resource damage following the project.

Aquatic insects were collected in 2003, 2004 and 2012. These samples were submitted to the Utah State University Bug Lab for processing. Results of processing for 2003 and 2004 are displayed in Table 2 as very good water quality. Aquatic organisms collected in 2012 have not been processed to date.

Table 3: Aquatic Insect Data for Little Boulder Creek

Stream	County	Sampling Date	Water quality Degree of organic pollution (Hilsenhoff, 1977)	Hilsenhoff Biotic Index
Little Boulder Creek	Tulare	8/6/2003	Very good Possible slight organic pollution	3.82
Little Boulder Creek	Tulare	7/7/2004	Very good Possible slight organic pollution	4.04
Little Boulder	Tulare	5/16/2012	Unknown - processing	processing

Creek				
-------	--	--	--	--

Aquatic insects identified in 1976 surveys included caddisflies, mayflies, and stoneflies as the most common species. Trout reproduction was described as very good in the upper reaches to fair in the lower reaches. Rainbow trout were abundant and were seen from 1-8 inches in length with an average of 5-6 inches.

A Longitudinal profile is provided to show cross section locations and an overview of the habitat types in Little Boulder Creek. Subsequent surveys repeat cross section surveys and other metrics; however unless the site has been affected by a fire, flood or other catastrophic event the longitudinal profile is not resurveyed. Little Boulder Creek was surveyed in 2003, 2004, and 2012. Review of the survey indicated that it represents the current condition of the study reach. Figure 1 displays the 2003 longitudinal profile for Little Boulder Creek and location of cross sections.

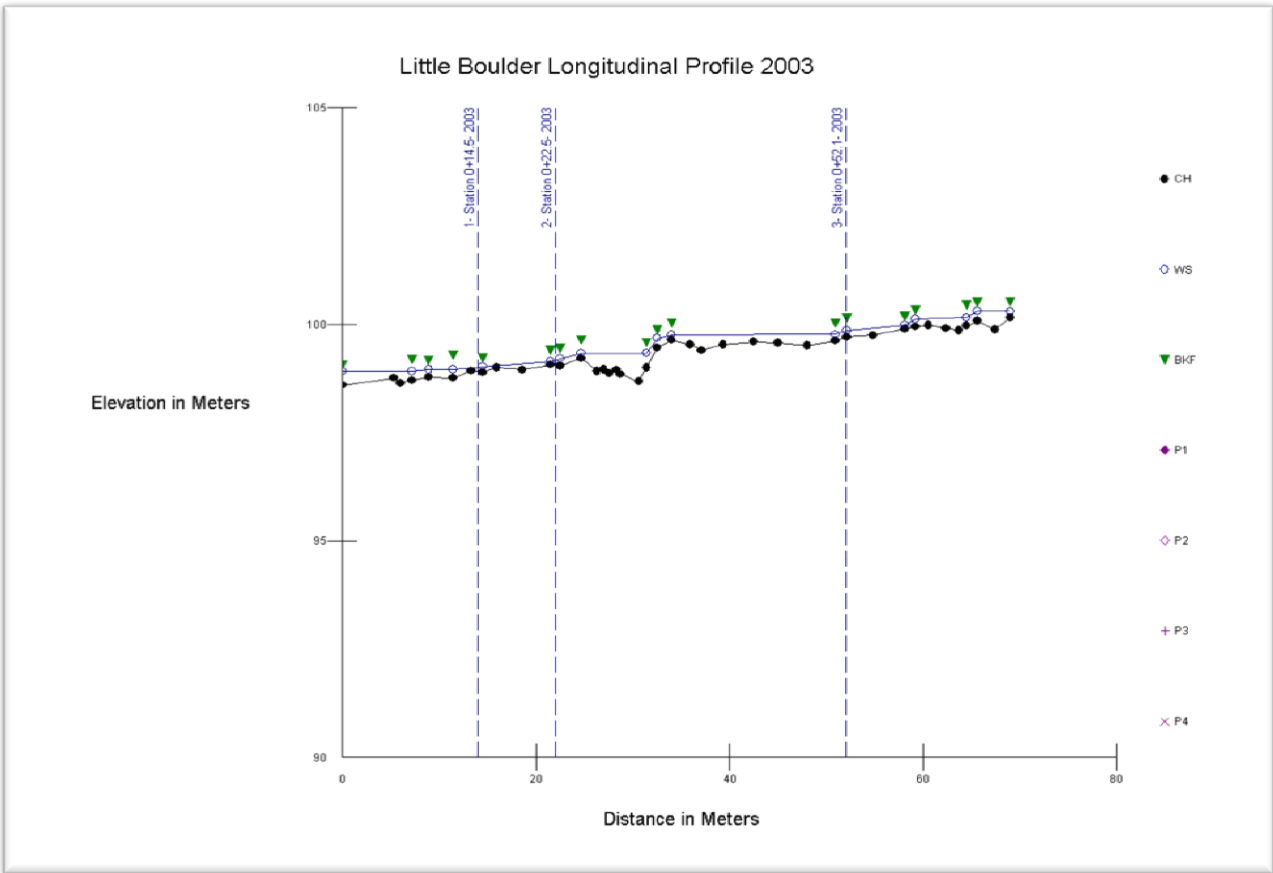


Figure 2- 2003 Longitudinal Profile of Little Boulder Creek

Cross sections were repeated for all survey years. Cross section 1, 2, and 3 illustrate the consistent conditions in the reach. Cross sections and particle counts are shown in figures 3-6.

Figure 3 Cross-Section 1 Little Boulder Creek

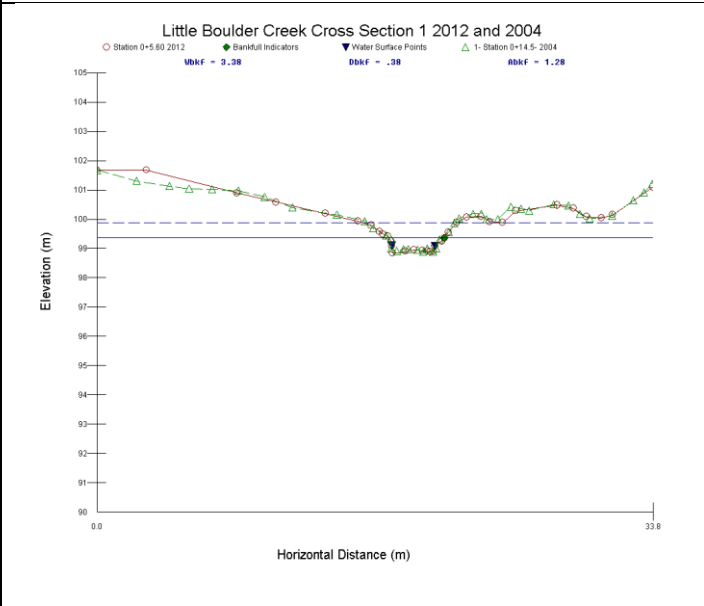


Figure 4 Cross-Section 2 Little Boulder Creek

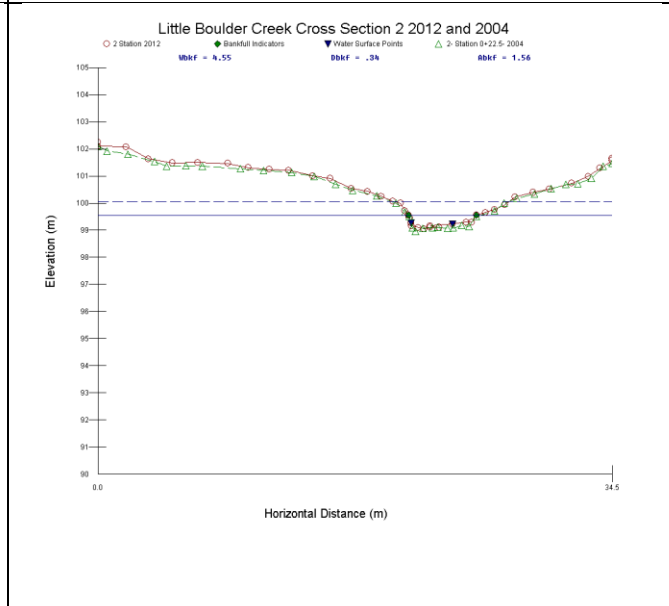


Figure 5 Cross-Section 3 Little Boulder Creek

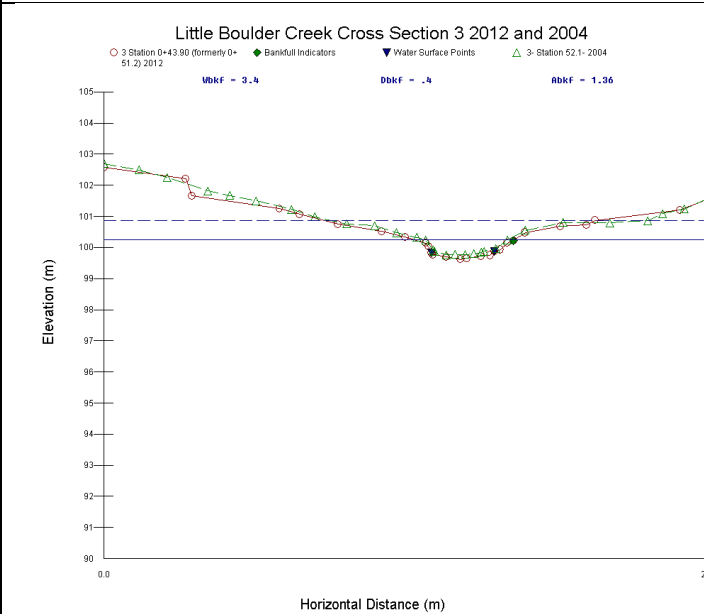
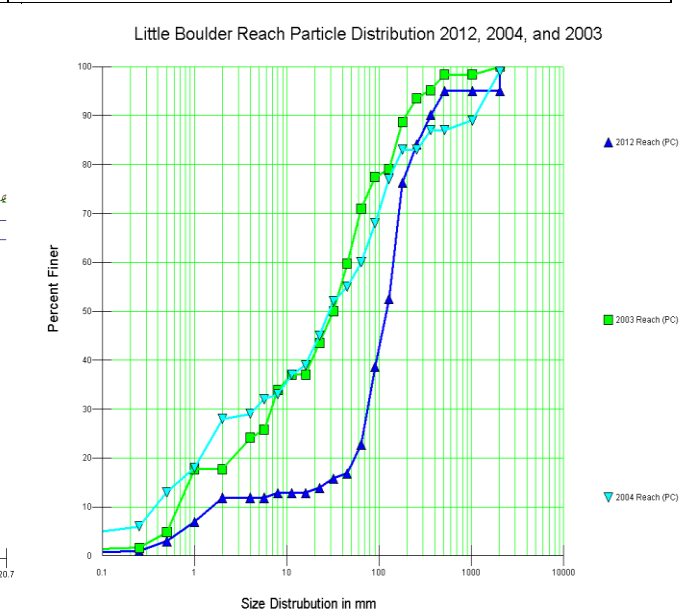


Figure 6 Reach Particle Distribution Little Boulder Creek



Particle distribution of channel bottom material for Little Boulder Creek is provided in figure 5. Particle distribution for Boulder Creek indicates a coarsening of channel bottom material from 2003/4 to 2012 indicating less deposition of fine material.

It appears as if Little Boulder Creek has improved habitat conditions since the initial surveys of 2003/2004. Channel type has not changed and remains a B4 channel type (Rosgen, 1994). Pfankuch Stability evaluations indicate a transition from fair to good stability.

Buck Rock Creek (2E-E)

Buck Rock Creek is a Class II stream that has been surveyed numerous times over the years. It was intensively surveyed for fisheries and fish habitat conditions from mouth to headwaters in 1976. Rock formed pools and riffles were found to be common. A dense shade canopy of cedar, fir, and pine was present and aquatic vegetation was abundant. Rainbow trout were seen at a rate of 7-8 per feet of stream ranging from 2 to 6 inches long with an average of 4-5 inches. Stream stability was moderate however streambanks were found to be unstable in areas with over 50 percent erosion. Stream gradient overall is moderate and increases in the headwaters region. This survey noted a layer of silt covering about 50% of the bottom and logging debris in the channel.

Channel stability surveys in 1989 support the earlier survey. The channel is characteristic of a Naturally-Stable riparian ecotype comprised of boulder and bedrock for roughly 90% of the drainage. A few sections of the channel showed cutting and deposition. Section of channel below Forest Road 14S02 is unstable and associated with steep gradient and steep streambanks. Bankcuts of 3 to 4 feet are common and are associated with sediment deposition.

Unnamed Tributary to Little Boulder Creek (2E-E)

The unnamed tributary to Little Boulder Creek is a Class III stream with no known fisheries. The tributary flows approximately 1.25 linear miles to its confluence with Little Boulder Creek. Burton Meadow is located at the head of this drainage. The lowermost 85 percent of the drainage is naturally-stable with steep to moderate gradient bedrock boulder and cobble dominated channels. The remaining portion is a naturally-unstable steep gradient gravel dominated channel.

A half healed over road failure was noted from a 1995 stream survey on the Middle Fork of Little Boulder Creek. The Road was identified as an old logging road. Burton meadow was identified in 1989 watershed improvement inventory as being damaged in the vicinity of Forest Road 13S26F. This survey indicated that dully erosion was present and associated with the road and past clear-cuts. Gullying and head-cutting was present at the top of the meadow and measured 5'x3'x40'. Recent reviews of the site indicate that the meadow has stabilized.

Lower Boulder Creek Basin (2F)

Lower Boulder Creek basin encompasses approximately 5,250 acres that drains approximately 15.3 linear miles of perennial streams into the South Fork Kings River. Boulder Creek encompasses approximately 6.25 linear miles.

Grizzly Lakes, Jennie Ellis Lake, and Weaver Lake are the only large water bodies in this watershed and have been stocked with non-native fish species starting in the early 1900s. Native and introduced fish species are found in perennial streams. Introduced fish species have “naturalized” over the years and displaced native Trout in the Kings River.

Natural disturbances to water quality include wildfires and floods. Large floods were recorded in January of 1997 which was reported to have moved boulders the size of houses and eroded Highway 180 in at least six locations. Human-caused impacts include roads, residences, recreation, grazing, stock use, and vegetation management. Past disturbances have the potential to affect water quality. Watersheds of concern due to past disturbances include Big Meadow Creek.

Redwood Creek (2F-B)

Redwood Creek is a Class III stream with all but its headwaters located in the wilderness. There are no known fisheries in Redwood Creek which flows for approximately two linear miles draining into the South Fork Kings River. Approximately 0.5 miles below the wilderness boundary Redwood Creek is extremely steep with bedrock cascades of approximately 800 feet vertical above highway 180, thick vegetation and has roughly 50 percent of the drainage associated with characteristics of a Naturally-Stable riparian ecotype. Approximately 20 percent of the channel is reflective of the Stable-Sensitive ecotype associated with low to moderated gradient depositional meadow and meadow-like areas. Most of these sites are located immediately upstream of spur road C and 13S05. A portion of this site is degraded.

Headwaters of Redwood Creek begin in a heavily wooded stand of conifer. Immediately downstream the creek shows evidence of erosion, sediment displacement and transport most likely associated with old logging activity and road runoff (sites 9 and 10 from 1995 surveys). Erosion appears to be associated with mass wasting in the area of the creek crossing and Road 13S05. Sediment from this location is present, transported downstream through the meadow section below the creek crossing. The effects of the past disturbance continue through a conifer stand in a step pool system which eventually transitions to meadow without a defined stream channel downstream of wilderness boundary and upstream of the end of spur C. This meadow appears very stable and well vegetated.

There are two sites in this watershed that were identified for restoration in past surveys. Site 9 and 10 from the 1995 stream surveys identifies stream bank erosion, gully erosion and mass wasting associated with natural conditions and old logging. The other site identifies gully

erosion and soil compaction associated with the road system. Sediment from the gully is documented to travel to the channel from culvert on road 13S05C. No road access is available to this site, and wasn't able to be evaluated. Recent field visit indicate a hill slope failure on road 13S05. These sites would be evaluated post project to determine resource condition.

Lockwood Creek (2F-C)

Lockwood Creek is a Class III stream located partially within the Monarch Wilderness and has no known fisheries. Lockwood creek encompasses approximately two linear miles of channel that drain north into the South Fork Kings River. Lockwood Creek has dense thick vegetation creating impassable conditions below the wilderness boundary. Above the wilderness boundary Lockwood Creek transitions between an Unstable-Sensitive-Degraded riparian ecotype where the channel shows active downcutting, abandoned floodplains; typical of Naturally-Unstable riparian ecotypes associated with steep fine-grained unstable land types. Downcut channels are present immediately upstream of the wilderness boundary and where Forest Road 13S06 is adjacent to the creek. The remaining portion of the channel is a bedrock-boulder controlled Naturally-Stable riparian ecotype with steep gradient channels.

Two sites in this watershed were identified for restoration in the 1995 stream surveys. One site is associated with stream channel erosion and undercut banks associated with natural causes. This site is located roughly at 5,600 feet elevation. The other site is associated with Forest Road 13S06, an abandoned trail, and an abandoned road with gully erosion and stream bank instability that in 1995 was roughly 8' deep by 10' wide. The site was not evaluated as road access is not currently available. This site could be evaluated post project if it appears to be negatively affected by the project.

Windy Gulch (2F-D)

Windy Gulch is a Class III stream located predominately in the Monarch Wilderness. There are no known fisheries in Windy Gulch Creek. Headwaters of the drainage lie outside the wilderness. The channel encompasses approximately 2.5 linear miles, which drain into the South Fork Kings River. Steep gradient Naturally-Stable riparian ecotype dominates the channel which is comprised of bedrock and boulders over approximately 50 percent of its length. The uppermost portion of the drainage above Forest Road 13S44 is a Naturally-Unstable riparian ecotype associated with steep-gradient, fine-grained, unstable landforms. Stable-Sensitive riparian ecotype conditions, associated with low to moderate gradient depositional areas, are present below the initial head walls of the basin and form a steep meadow for approximately 1,700 feet.

The head of this meadow is crossed by an old road that no longer shows up on forest maps, and was previously identified as 13S44. At the intersection of the meadow and the old road gully erosion is present as the creek has cut through the old road prism. Sediment from this site

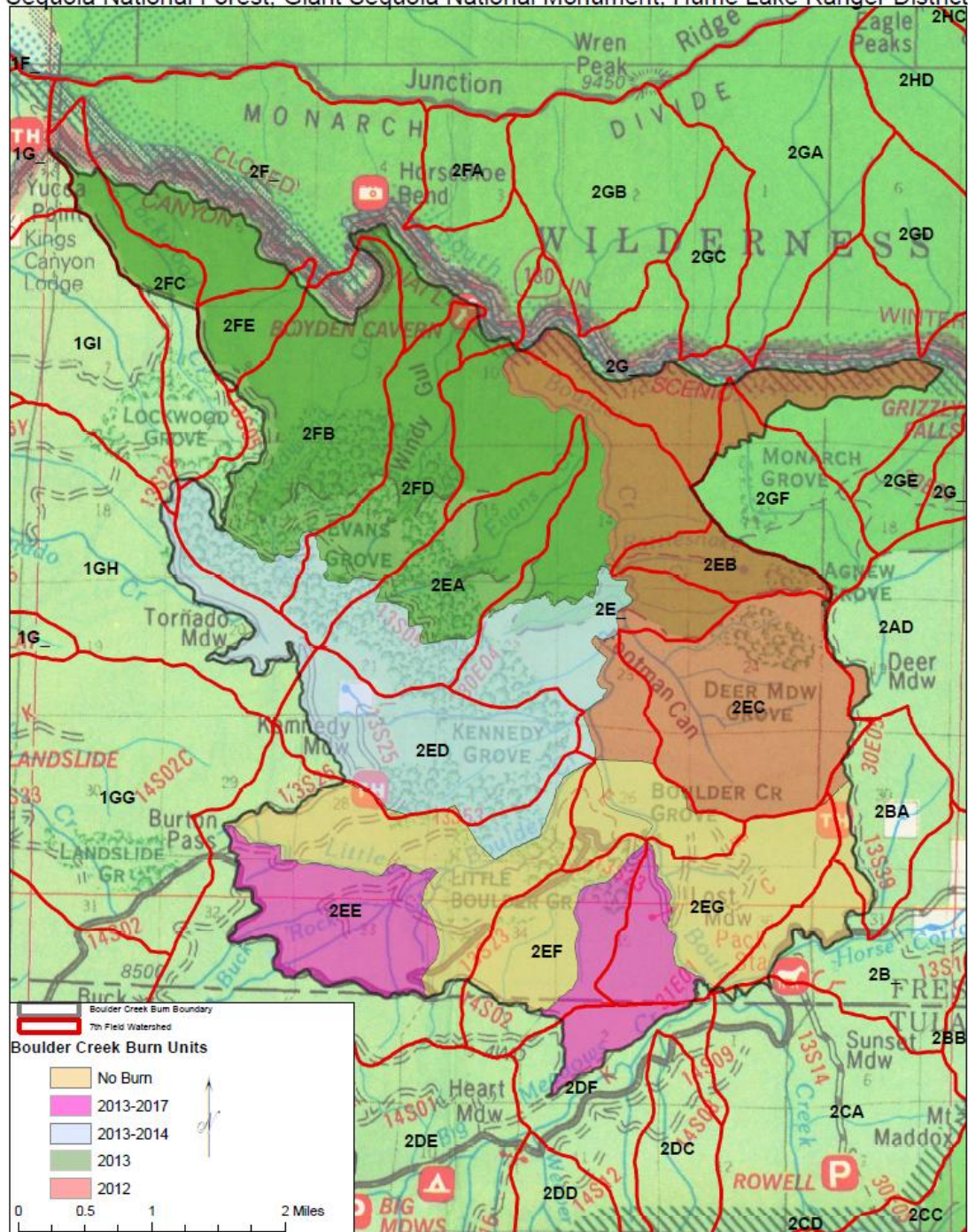
continues to be deposited downstream. The channel transitions to a meandering channel for a short distance before it becomes a steep bedrock cascade at the wilderness boundary which continues to the Kings River.

A restoration site in Windy Gulch watershed was identified in the 1995 stream survey. Gully erosion associated with abandoned road 13S44 was documented. The channel has cut through the road prism and deposited the sediment into the meadow. The gully size at the time of the 1995 survey was 15' wide and 8' deep. Recent site visits indicate that the meadow in Windy Gulch has since stabilized and is no longer in need of restoration.

Proposed Action

The Forest Service proposes to use prescribed fire to reintroduce fire into the lower portion of the Boulder Creek drainage. The project area encompasses approximately 14,385 acres of the watershed, of which 6,000 to 9,000 acres would be proposed for underburning (see Figure 7). The smaller amount of treatment acres is due to large areas of rock and other features that would need other treatments prior to, or instead of, prescribed fire.

Boulder Burn Project Map, Hydrology
Sequoia National Forest, Giant Sequoia National Monument, Hume Lake Ranger District



8/2012
SQF Hydro, H Kwan

Figure 7- Map showing HUC 7 Watersheds and Proposed Burn Units by Year

MANAGEMENT DIRECTION

There are a number of laws, regulation and policy applicable to managing soil and water quality including the Clean Water Act and the Sequoia National Forest Land and Resource Management Plan (LRMP), as amended. The Boulder Environmental Assessment follows management direction in the 1988 Sequoia National Forest Land and Resource Management Plan as amended by the 2012 Giant Sequoia National Monument Management Plan.

2000 Proclamation

The presidential proclamation that established Giant Sequoia National Monument placed a charge to protect the Objects of Interest while allowing continued uses:

“These forests need restoration to counteract the effects of a century of fire suppression and logging. Fire suppression has caused forests to become denser in many areas, with increased dominance of shade-tolerant species. Woody debris has accumulated, causing an unprecedented buildup of surface fuels. One of the most immediate consequences of these changes is an increased hazard of wildfires of a severity that was rarely encountered in pre-Euro American times.”

“The goal of protecting and restoring desired conditions of aquatic, riparian and meadow ecosystems and providing for the viability of species associated with those ecosystems remains unchanged. With this decision, I am retaining the Critical Aquatic Refuges, the Riparian Conservation Areas, and the goals of the Aquatic Management Strategy established in the SNFP 2001 ROD.”

“The fundamental principle of the AMS is to retain, restore, and protect the processes and landforms that provide habitat for aquatic and riparian-dependent organisms, and produce and deliver high-quality waters for which the National Forests were established” (USDA Forest Service 2001, Record of Decision, Appendix A, page A-5). The AMS includes the designation of riparian conservation areas (RCAs) along streams and around water bodies and critical aquatic refuges (CARs). RCAs focus on preserving, enhancing, and restoring habitat for riparian and aquatic-dependent species, ensuring that water quality is maintained or restored, enhancing habitat conservation for species associated with the transition zone between upslope and riparian areas, and providing greater connectivity within watersheds.

Table 4: Management Direction and Reference

Direction	2012 GSNM
Desired Conditions	Management Plan pp. 22

Strategies/ Objectives for Hydrologic Resources	Management Plan p. 53
Hydrologic Resources Standards and Guidelines	Management Plan p. 95 102
Critical Aquatic Refuges (CARs)	Management Plan p. 97
Riparian Conservation Areas (RCAs)	Management Plan p. 96-97
Riparian Conservation Objectives (RCOs)	Management Plan p. 97-102

Aquatic Management Strategy (AMS)

The AMS has core elements including the adaptive management strategy for aquatic and riparian ecosystems. Four of the five management elements of the GSNM apply: AMS, RCAs, RCOs, and CARs with their associated standards and guidelines. Applicable management requirements and constraints from the GSNM include:

X Aquatic Management Strategy goals and objectives

X Riparian Conservation Areas

X Riparian Conservation Objective analysis of standards and guidelines

 Critical Aquatic Refuges

 Long-term strategy for anadromous fish-producing watersheds

RCO Analysis

The RCOs listed in the Giant Sequoia National Monument Plan Record of Decision were reviewed for applicability to the project. RCOs 1-4, in addition to RCO direction, apply to the project and are further reviewed below. RCO 5 does apply, but to detrimental affect fins exist within the project area and no range activities are proposed. RCO 6 does not apply no in channel restoration practices proposed. The following RCOs were reviewed for applicability to the Boulder Project.

X 1. Ensure that identified beneficial uses for the water body are adequately protected. Identify the specific beneficial uses for the project area, water quality goals from the Regional Basin Plan, and the manner in which the standards and guidelines will protect the beneficial uses.

X ____ 2. Maintain or restore: (1) the geomorphic and biological characteristics of special aquatic feature, including lakes, meadows, bogs, fens, wetlands, vernal pools, springs; (2) streams, including in stream flows; (3) hydrologic connectivity both within and between watersheds to provide for the habitat needs of aquatic-dependent species.

X ____ 3. Ensure a renewable supply of large down logs that: (1) can reach the stream channel and (2) provide suitable habitat within and adjacent to the RCA.

X ____ 4. Ensure that management activities, including fuels reduction actions, within RCAs and CARs enhance or maintain physical and biological characteristics associated with aquatic- and riparian-dependent species.

____ 5. Preserve, restore, or enhance special aquatic features, such as meadows, lakes, ponds, bogs, fens and wetlands, to provide the ecological conditions and processes needed to recover or enhance the viability of species that rely on these areas.

____ 6. Identify and implement restoration actions to maintain, restore or enhance water quality and maintain, restore, or enhance habitat for riparian and aquatic species.

____ Critical Aquatic Refuges (CARs)

Riparian Conservation Objectives

Standards and Guidelines for Riparian Conservation Areas and Critical Aquatic Refuges

13. Designate riparian conservation area (RCA) widths as described in Part B of the [2004 SNFPA] appendix. The RCA widths displayed in Part B may be adjusted at the project level if a landscape analysis has been completed and a site-specific RCO analysis demonstrates a need for different widths.

No changes to the RCA widths were deemed necessary for the Boulder Project.

14. (1-6) Evaluate new proposed management activities within CARs and RCAs during environmental analysis to determine consistency with the riparian conservation objectives at the project level and the AMS goals for the landscape. Ensure that appropriate mitigation measures are enacted to (1) minimize the risk of activity-related sediment entering aquatic systems and (2) minimize impacts to habitat for aquatic- or riparian-dependent plant and animal species.

The proposed fuels reduction activities are consistent with the guidelines for managing the RCAs. This report provides documentation of the evaluation of effects to the watershed and the project's consistency with riparian conservation objectives. No mitigations have been identified or are required to implement Alternative 2.

15. (1-7) Identify existing uses and activities in CARs and RCAs during landscape analysis. At the time of permit reissuance, evaluate and consider actions needed for consistency with RCOs.

The project does not include a landscape analysis or issuance of permits. However, existing uses and activities are considered in the cumulative effects analysis discussed later in this document. No CAR's exist within the project boundary.

16. As part of project-level analysis, conduct peer reviews for projects that propose ground-disturbing activities in more than 25 percent of the RCA or more than 15 percent of a CARs.

Less than 25 percent of the RCA's within the project area are predicted to be affected by the proposed action. There is no CAR located within the project area.

Standards and Guidelines Associated with RCO #1

17. For waters designated as "Water Quality Limited" (Clean Water Act Section 303(d)), participate in the development of Total Maximum Daily Loads (TMDLs) and TMDL Implementation Plans. Execute applicable elements of completed TMDL Implementation Plans.

No water bodies identified by the State as "Water Quality Limited" are in or affected by this project area.

18. Ensure that management activities do not adversely affect water temperatures necessary for local aquatic- and riparian-dependent species assemblages.

Maintain temperature at no more than daily average of 20° C on streams affected by management activities. Evaluate stream courses with special circumstances, such as those affected by hot springs or other geologic and geothermal features, on a site-by-site basis at the project level.

Maintain average stream surface shading at >60 percent on streams affected by management activities. Assess meadow environments and streams with limited overhead vegetation on a site-by-site basis at the project level.

Ensure that management activities do not adversely affect pH values necessary for local aquatic and riparian-dependent species as defined by the Central Valley Water Quality Board Basin Plan. Maintain pH values between 6.5 and 8.5 on streams affected by management activities. Evaluate water bodies that exhibit special conditions at the project level, including waters affected by hot springs in the presence of CO₂ springs or other geologic and geochemical features (such areas would be expected to yield pH values outside the range of State standards).

Ensure that management activities do not adversely affect alkalinity values, which can affect pH values, necessary for local aquatic- and riparian-dependent species as defined by the Central

Valley Water Quality Board Basin Plan. Maintain alkalinity values of no less than 10 mg/L. Site-specific differences could occur based on local geology and water chemistry. Evaluate values outside this range at the project level.

None of the proposed activities should affect local aquatic and riparian-dependent species assemblages.

19. Limit pesticide applications to cases where project level analysis indicates that pesticide applications are consistent with riparian conservation objectives.

No pesticide use is proposed in this project so this standard is not applicable.

20. Within 500 feet of known occupied sites for the California red-legged frog, Cascades frog, Yosemite toad, foothill yellow-legged frog, mountain yellow-legged frog, and northern leopard frog, design pesticide applications to avoid adverse effects to individuals and their habitats.

No pesticide use is proposed in this project so this standard is not applicable.

21. Prohibit storage of fuels and other toxic materials within RCAs and CARs except at designated administrative sites and sites covered by a Special Use Authorization. Prohibit refueling within RCAs and CARs unless there are no other alternatives. Ensure that spill plans are reviewed and up-to-date.

Storage of fuels or refueling would not occur within RCA's. (No CAR's within project area.)

Standards and Guidelines Associated with RCO #2

22. Maintain and restore the hydrologic connectivity of streams, meadows, wetlands, and other special aquatic features by identifying roads and trails that intercept, divert, or disrupt natural surface and subsurface water flow paths. Implement corrective actions where necessary to restore connectivity.

The proposed action does not alter hydrologic connectivity of aquatic features. Information associated with the identification of special aquatic features affected by roads and trails has been added to the affected environment to provide the opportunity to mitigate potential effects of the proposed action and to provide the opportunity to implement corrective actions either during project implementation or future projects.

23. Ensure that culverts or other stream crossings do not create barriers to upstream or downstream passage for aquatic-dependent species. Locate water drafting sites to avoid adverse effects to in stream flows and depletion of pool habitat. Where possible, maintain and

restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows, wetlands, and other special aquatic features.

Proposed activity does not create flow diversions. It is expected that the proposed action would not substantially alter stream flow as long as burning occurs as prescribed. Post project monitoring of stream channel conditions would be implemented.

24. Prior to activities that could adversely affect streams, determine if relevant stream characteristics are within the range of natural variability. If characteristics are outside the range of natural variability, implement mitigation measures and short-term restoration actions needed to prevent further declines or cause an upward trend in conditions. Evaluate required long-term restoration actions and implement them according to their status among other restoration needs.

Pacific Southwest Region Stream Condition Inventory protocol (SCI) was implemented in the Little Boulder Creek drainage within the project area to monitor disturbance for the Boulder Burn Project. Results for the SCI survey are documented in the affected environment.

27. At either the landscape or project-scale, determine if the age class, structural diversity, composition, and cover of riparian vegetation are within the range of natural variability for the vegetative community. If conditions are outside the range of natural variability, consider implementing mitigation and/or restoration actions that will result in an upward trend. Actions could include restoration of aspen or other riparian vegetation where conifer encroachment is identified as a problem.

Proposed activity would contribute an upward trend of age class, structural diversity, composition and riparian vegetation.

28. Cooperate with Federal, Tribal, State and local governments to secure in stream flows needed to maintain, recover, and restore riparian resources, channel conditions, and aquatic habitat. Maintain in stream flows to protect aquatic systems to which species are uniquely adapted. Minimize the effects of stream diversions or other flow modifications from hydroelectric projects on threatened, endangered, and sensitive species.

No diversions proposed by the project, stream flow would not be reduced by the proposed action.

Standards and Guidelines Associated with RCO #3

30. Determine if the level of coarse large woody debris (CWD) is within the range of natural variability in terms of frequency and distribution and is sufficient to sustain stream channel

physical complexity and stability. Ensure proposed management activities move conditions toward the range of natural variability.

Past monitoring efforts has evaluated CWD is within the range of natural variability. Little loss of CWD due to fire is predicted within the riparian area because the fire intensity should be low in those areas.

Standards and Guidelines Associated with RCO #4

31. Within CARs, in occupied habitat or "essential habitat" as identified in conservation assessments for threatened, endangered, or sensitive species, evaluate the appropriate role, timing, and extent of prescribed fire. Avoid direct lighting within riparian vegetation; prescribed fires may back into riparian vegetation areas. Develop mitigation measures to avoid impacts to these species whenever ground-disturbing equipment is used.

No proposed lighting of fire would occur within riparian vegetation, all ignition sites would be on ridge tops when fire would be allowed to back into riparian vegetation areas.

32. Use screening devices for water drafting pumps. (Fire suppression activities are exempt during initial attack.) Use pumps with low entry velocity to minimize removal of aquatic species, including juvenile fish, amphibian egg masses and tadpoles, from aquatic habitats.

During project activities water drafting may occur to provide support to fire lines. Screening devices and low velocity intakes would be used.

33. Design prescribed fire treatments to minimize disturbance of ground cover and riparian vegetation in RCAs. In burn plans for project areas that include, or are adjacent to RCAs, identify mitigation measures to minimize the spread of fire into riparian vegetation. In determining which mitigation measures to adopt, weigh the potential harm of mitigation measures, for example fire lines, against the risks and benefits of prescribed fire entering riparian vegetation. Strategies should recognize the role of fire in ecosystem function and identify those instances where fire suppression or fuel management actions could be damaging to habitat or long-term function of the riparian community.

All fire would be initiated from ridge tops and allowed to back down into riparian areas. By lighting from ridge tops and allowing the fire to back down fire intensities should be low or unburned within riparian areas. Proper fuel moisture and weather conditions would also contribute to reducing fire intensities with riparian areas.

36. As appropriate, assess and document aquatic conditions following the Regional Stream Condition Inventory protocol prior to implementing ground disturbing activities within suitable

habitat for California red-legged frog, Cascades frog, Yosemite toad, foothill and mountain yellow-legged frogs, and northern leopard frog.

Pacific Southwest Region Stream Condition Inventory protocol (SCI) was done on Little Boulder Creek within the project area to monitor disturbance for the Boulder Project. Results for the SCI survey are within discussed in the affected environment.

38. Identify roads, trails, OHV trails and staging areas, developed recreation sites, dispersed campgrounds, special use permits, grazing permits, and day use sites during landscape analysis. Identify conditions that degrade water quality or habitat for aquatic and riparian-dependent species. At the project level, evaluate and consider actions to ensure consistency with standards and guidelines or desired conditions.

These uses and conditions that have the potential to degrade water quality are explained further within the cumulative watershed effects section (CWE). Opportunities identified for the restoration of sites associated with degraded water quality or habitat conditions are provided in the affected environment.

Best Management Practices

Forest management and associated road building in the steep rugged terrain of forested mountains has long been recognized as sources of non-point water quality pollution. Non-point pollution is not, by definition, controllable through conventional treatment means. Non-point pollution is controlled by containing the pollutant at its source, thereby precluding delivery to surface water. Sections 208 and 319 of the Federal Clean Water Act, as amended, acknowledge land treatment measures as being an effective means of controlling non-point sources of water pollution and emphasize their development.

In August 2010, the Ninth Circuit Court ruled in NEDC vs. Brown that storm water runoff from logging roads that is collected by and then discharged through a system of ditches, culverts, and channels to streams comprises a point source of water pollution. Point sources of pollution require National Pollution Discharge Elimination System (NPDES) permits. Currently, the Regional Office is working with both the U.S. Environmental Protection Agency and the State Water Resources Control Board (SWRCB) to develop interim guidance that will likely avoid the need for Forests to apply for individual NPDES permits while the Regional Office works with the SWRCB to develop a general statewide NPDES permit. Based upon existing general permits, implementation of Best Management Practices and monitoring are likely to be key components of a statewide NPDES permit. The Forest Service is already implementing Best Management Practices and conducting monitoring as part of its 1981 Management Agency Agreement (MAA) with the SWRCB, and the Regional Office is currently working with the SWRCB and RWQCBs to

revise our BMPs and monitoring program. Forests are directed to continue implementation of our Best Management Practices for all road activities.

Petitions for rehearing and rehearing en banc were filed on October 5, 2010, contending that subject matter jurisdiction was improper, and that issue had not been discussed in the August opinion. In a replacement opinion, *NEDC v. Brown*, No. 07-35266, 2011 WL 1844060, filed May 17, 2011, the Ninth Circuit determined that subject matter jurisdiction was in fact proper. The court also reiterated its previous analysis of the Silviculture Rule. Finally, the court denied a petition for rehearing and rehearing en banc. However, the court did concede that the Silviculture Rule should be construed as consistent with the Clean Water Act ("CWA") so long as the "natural runoff" remains natural. That is, the exemption ceases to exist as soon as the natural runoff is channeled and controlled in some systematic way through a "discernible, confined and discrete conveyance" and discharged into the waters of the United States. This two-part test may allow some logging operations to remain exempt where the "natural runoff" is not discharged into streams and rivers.

Working cooperatively with the California State Water Quality Control Board, the Forest Service developed and documented non-point pollution control measures applicable to National Forest System lands. These measures were termed "Best Management Practices" (BMPs). BMP control measures are designed to accommodate site specific conditions. They are tailor-made to account for the complexity and physical and biological variability of the natural environment. The implementation of BMP is the performance standard against which the success of the Forest Service's non-point pollution water quality management efforts is judged.

The Clean Water Act provided the initial test of effectiveness of the Forest Service non-point pollution control measures where it required the evaluation of the practices by the regulatory agencies (State Board and EPA) and the certification and approval of the practices as the "BEST" measures for control. Another test of BMP effectiveness is the capability to custom fit them to a site-specific condition where non-point pollution potential exists. The Forest Service BMPs are flexible in that they are tailor-made to account for diverse combinations of physical and biological environmental circumstances. A final test of the effectiveness of the Forest Service BMP is their demonstrated ability to protect the beneficial uses of the surface waters in the State.

Best Management Practices, as described in this document have been effective in protecting beneficial uses within other projects on the Sequoia National Forest. Where proper implementation has occurred there have not been any substantive adverse impacts to cold water fisheries, habitat conditions, or any of the other beneficial uses of the surface waters (See Table 1). The practices specified herein are expected to be equally effective in maintaining

the identified beneficial uses. Alternative 2 includes the applicable Best Management Practices (BMPs) to protect water quality in accordance with Water Quality Management for National Forest System Lands in California (USDA Forest Service, 2011). The following BMPs are applicable under this alternative:

2.11 Equipment Refueling and Servicing:

The objective of this BMP is to prevent fuels, lubricants, cleaners and other harmful materials from discharging into nearby surface waters or infiltrating through soils to contaminate groundwater resources.

All potential refueling would take place outside of the project area. Potential helicopter refueling and servicing sites include the Yucca heliport (off of spur road 13S95), Pinehurst work center, and other established heliport sites.

Chemical management plans including a spill response plan will be in place.

2.13 Erosion Control Plan:

The Erosion Control Plan can be found in Appendix B.

6.1 Fire and Fuels Management Activities

The objective of this BMP is to reduce public and private loss and environmental impacts which result from wildfires and/or subsequent flooding and erosion by reducing or managing the frequency, intensity and extent of wildfire.

The Boulder Project readily meets the objectives of this BMP by: reducing the potential for catastrophic fire, allow for a more natural frequency of fire in the area, managing the intensity of the fire by igniting when conditions are favorable and letting the fire back down from ridge tops, and using natural barriers and previous fires to control the extent of the fire.

6.2 Consideration of Water Quality in Formulating Fire Prescription

The objective of this BMP is to provide for water-quality protection while achieving the management objectives through the use of prescribed fire.

Water-quality protection would be achieved by igniting the fire on ridge tops and then allowing the fire to back down resulting in low fire intensity in riparian conservation areas. The fire prescription would include acceptable mortality within the riparian zone, the need to use low velocity intakes and screens at designated drafting sites, no storage of fuels/ or refueling of fuels would occur

within RCA's, not igniting in riparian zones, and minimal riparian canopy cover loss.

6.3 Protection of Water Quality from Prescribed Burning Effects

The objective of this BMP is to maintain soil productivity; minimize erosion; and minimize ash, sediment nutrients and debris from entering water bodies.

Water-quality protection would be achieved by igniting the fire on ridge tops and then allowing the fire to back down. By using this method it allows for fire to be less intense near riparian areas allow for a buffer and create a mosaic burn pattern resulting in small areas of contiguous high burn severity. The desired prescription for prescribed burn is 5 percent high, 10 percent moderate, 65 percent low and 20 percent unburned, for soil burn severity. (Monument Plan, 2010)

Cumulative Watershed Effects

Past and present activities within the analysis area include grazing, wildfire, previous prescribed burning, timber harvest and plantation management, road construction and reconstruction, road maintenance, trail construction and maintenance, recreational use, and private land uses.

The following table displays an analysis of the South Fork King River/ Lower CWE analysis. The analysis was performed at the HUC 6 watershed level and provides information on: equivalent roaded acres (ERAs) available, ERAs used by project, and remaining ERA's available for management prior to reaching threshold of concern (TOC)¹. The CWE analysis includes implementation of the Boulder Burn Project and the future road maintenance project on road 13S05 and trail maintenance. Based on the Berg and Azuma (2008) study, it is assumed cumulative effects of wildfire and prescribed fire related activities recover after 4 years. To provide for a more conservative approach it is assumed the potential for CWE would be less after 5 years and therefore a 5-year fire recovery is to assess CWE associated with fire-related events.

Alternative 1- No Action and No Action with Fire

² The Threshold of Concern (TOC) is expressed as a percentage (% of ERA's used) and represents the potential risk a subwatershed may have as it approaches and exceeds its threshold.

The No Action Alternative would have minimal impact on water quality, stream stability, temperature, and soil loss. Based on the current level of effects, existing channel types, vegetation cover, riparian ecotypes, stream stability surveys after Pfankuch, 1975, and past management activities, stream channels would maintain stable conditions. An analysis of the RCOs was not conducted for this alternative as no activities are proposed.

Table 5: ERA's for South Fork King River/ Lower (180300100304)

6th Field Watershed	Watershed Name	Subwatershed ERAs	ERAs Used to Date	ERAs Remaining
180300100304	South Fork King River/ Lower	976	224.2	751.8

The No Action Alternative with Fire would have a higher potential to effect water quality, stream stability temperature and soil loss. Wildfire has an estimated effect of 0.27era/acre (Draft Monument Plan, 2012). Figure 7 and Table 4 show the potential effects of a wildfire within the project area. Figure 7 below analyses the 9,300 acre area proposed for the Bolder Burn Project as a wildfire. The effect of a wildfire of this magnitude would result in a dramatic leap into negative EAR's. . The result of a wildfire within the proposed project area would increase the potential for detrimental effects to watershed health. As analyzed, ERA's change from 751.8 to -1759.2 as a result of a wildfire in the project area.

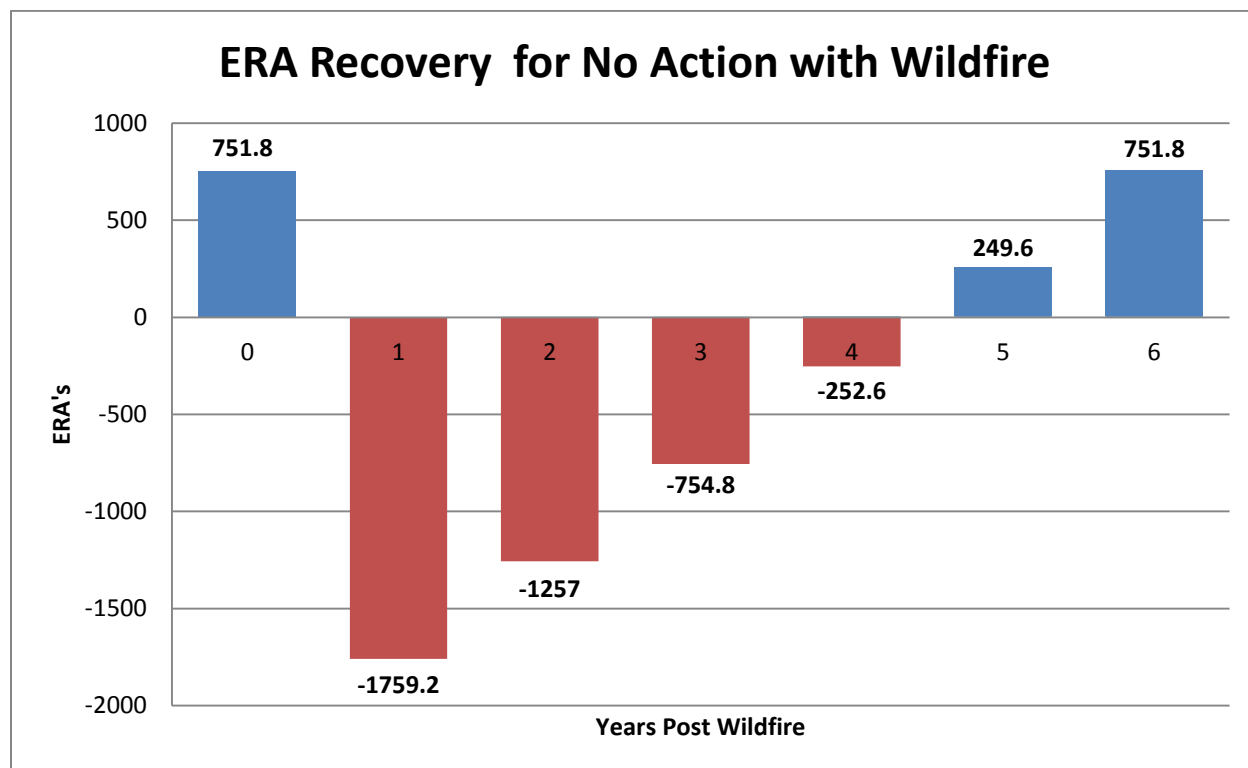


Figure 7: No Action Alternative with Wildfire ERA recovery

Table 6: No Action Alternative with Wildfire ERA recovery

ERA Recovery Post Wildfire No Action	
Year Post-Fire	ERA's Remaining
0	751.8
1	-1759.2
2	-1257
3	-754.8
4	-252.6
5	249.6
6	751.8

Alternative 2- Proposed Action

The proposed activity increases the potential for watershed effects slightly above threshold during the project timeframe. This is shown in Figure 8 and Table 5. Despite the potential increase for cumulative effects, watershed health is expected to be enhanced as a result of the project and provide more resiliencies in its potential for future fires. Ash and potential sediment that does reach the channel is expected to be flushed out, especially in the channels closer to the King's River that are bedrock controlled. The nearby Sheep Wildfire in 2010 produced sediment and ash into the Kings River, but now with increased groundcover in 2011, there is much less noticeable sediment runoff. With the ability to prescribe fire to meet specific constraints concerning attributes such as size, relative humidity, ignition sites, avoidance areas, and wind direction, watershed integrity can be maintained throughout the project. It is expected that the project would recover to above threshold five years following implementation and completely recover back to pre-project conditions ten years following implementation.

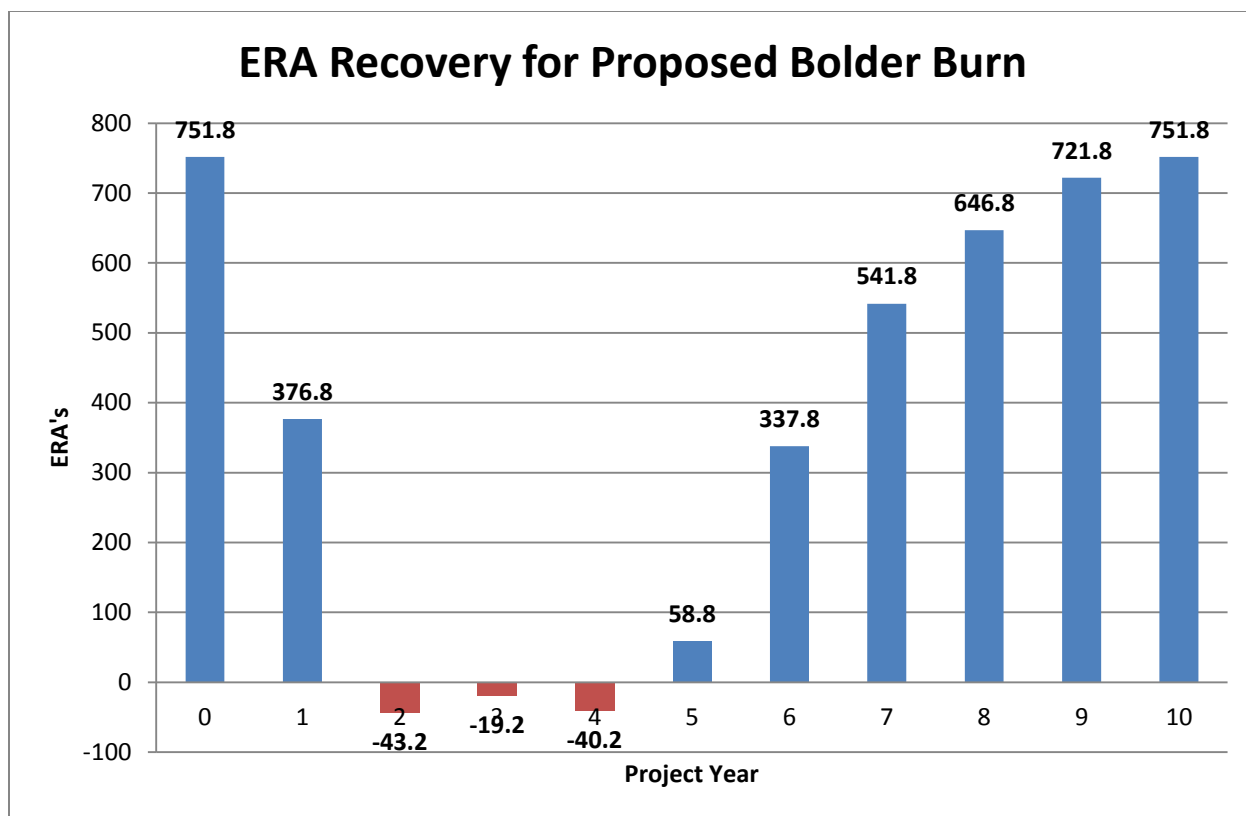


Figure 8: Proposed Action with ERA recovery

Table 7: Proposed Action with ERA Recovery

Pre-Proposed Action				
6th Field Watersheds	Acres	ERA's Available	ERA's Used	ERA's Remaining
South Fork Kings River/ Lower Boulder	0	751.8	0	751.8
Burn Year 1				
6th Field Watersheds	Acres	ERA's Available	ERA's Used	ERA's Remaining
South Fork Kings River/ Lower Boulder	2500	751.8	375	376.8
Burn Year 2				
6th Field Watersheds	Acres	ERA's Available	ERA's Used	ERA's Remaining
South Fork Kings River/ Lower Boulder	3300	451.8	495	-43.2
Burn Year 3				
6th Field Watersheds	Acres	ERA's Available	ERA's Used	ERA's Remaining
South Fork Kings River/ Lower Boulder	1000	130.8	150	-19.2
Burn Year 4				
6th Field Watersheds	Acres	ERA's Available	ERA's Used	ERA's Remaining
South Fork Kings River/ Lower Boulder	1500	184.8	225	-40.2
Burn Year 5				
6th Field Watersheds	Acres	ERA's Available	ERA's Used	ERA's Remaining

South Fork Kings River/ Lower Boulder	1000	208.8	150	58.8
Recovery Year 6				
6th Field Watersheds	Acres	ERA's Available	ERA's Used	ERA's Remaining
South Fork Kings River/ Lower Boulder	0	337.8	0	337.8
Recovery Year 7				
6th Field Watersheds	Acres	ERA's Available	ERA's Used	ERA's Remaining
South Fork Kings River/ Lower Boulder	0	541.8	0	541.8
Recovery Year 8				
6th Field Watersheds	Acres	ERA's Available	ERA's Used	ERA's Remaining
South Fork Kings River/ Lower Boulder	0	646.8	0	646.8
Recovery Year 9				
6th Field Watersheds	Acres	ERA's Available	ERA's Used	ERA's Remaining
South Fork Kings River/ Lower Boulder	0	721.8	0	721.8
Recovery Year 10				
6th Field Watersheds	Acres	ERA's Available	ERA's Used	ERA's Remaining
South Fork Kings River/ Lower Boulder	0	751.8	0	751.8

Areas that could cause for concern would include areas where previous resource damage has occurred. Hydrologic function in these areas may be diminished. Special concern would be provided for the following sites, by post project implementation evaluation: mass wasting from road 13S05C in Redwood Creek, erosion associated with road 13S06 in Lockwood Creek, compaction and erosion in headwaters of Little Boulder Creek, and erosion associated with old logging road in tributary to Little Boulder Creek, grazing on Little Boulder Creek, hillslope failure on road 13S05 in Redwood Creek. Sites of unknown condition would be inventoried post project to determine the potential for resource damage.

References

California Environmental Protection Agency (CEPA), 2004. Central Valley Regional Water Quality Control Board: Water Quality Control Plan for Tulare Lake Basin.

http://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/index.shtml

Hawkins, C.P. and D. M. Carlisle. 2001. Use of predictive models for assessing the biological integrity of wetlands and other aquatic habitats. pp. 59-84 in: R. B. Rader, D.P. Batzer and S.A. Wissinger, eds. Bioassessment and Management of North American Freshwater Wetlands, John Wiley and Sons, New York.

Hilsenhoff, W.L. 1982. Using a biotic index to evaluate water quality in streams. Technical Bulletin Wisconsin Department of Natural Resources 132.

- Phankuch, Dale J. 1975. Stream reach inventory and channel stability evaluation. U.S. Department of Agriculture, Forest Service, R1-75-002. Government Printing Office #696-260/200, Washington, D.C.; 26 pg.
- Rosgen, D.L. 1994. A classification of natural rivers. *Catena* 22 (1994):169-199.
- Rosgen, D.L. 1996. Applied River morphology. Wildland Hydrology. Pagosa Springs, CO. 376 pp.
- Rosgen, D.L. 2001. A Stream Channel Stability Assessment Methodology. In *Proceedings of the Seventh Federal Interagency Sedimentation Conference: Vol 1* (pp.II-18- II-26). Reno, NV: Subcommittee on Sedimentation.
- USDA Forest Service, 2004. Sierra Nevada Forest Plan Amendment. Pacific Southwest Region. Vallejo, California
- USDA Forest Service. 2011. Water Quality Management for Forest Systems Lands in California – Best Management Practices. Pacific Southwest Region, Vallejo, California.

Determination of Riparian Ecotypes

By Terry A. Kaplan Henry

Sequoia National Forest

May 2000

Introduction

Riparian ecotypes are grouped based on how the stream type responds to natural events (floods and fire) and land management activities (grazing, timber harvest, roads, fuels management, recreation, etc.) relative to similarities in their physical conditions. Channels are grouped to: 1) Identify key ecosystem elements that represent riparian ecosystem function and health and 2) describe riparian ecosystem existing conditions in terms of environmental indicators that are sensitive to change. To help identify key ecosystem elements environmental indicators for the individual riparian ecotypes were identified. The four riparian ecotypes are defined as follows.

Naturally Stable

This ecotype is inherently stable and comprised of bedrock, boulder and cobble controlled channels. It is not significantly influenced by land management activities. Sediment build-up can be concerns in some locally impacted areas. Figure 1, Scarlet and Davis Creek is an example of a Naturally-Stable riparian ecotype.



Figure 1. Naturally Stable Riparian Ecotype

Stable-Sensitive

This ecotype is inherently stable dominated by cobble, gravel, sand, and finer material. It is located in relatively flat riparian areas that are easily influenced by land management activities. This ecotype is comprised of streams typically associated with meadows with or without defined channels. This ecotype is stable and very susceptible to disturbances and changes in the flow, timing, and quality of water. Figure 2, Horse Meadow Creek is an example of a Stable-Sensitive riparian ecotype.



Figure 2. Stable Sensitive Riparian Ecotype

Unstable-Sensitive-Degraded

This ecotype has been degraded and represents severe alteration of another riparian ecotype. In most



Figure 3. Unstable-Sensitive Degraded Riparian Ecotype

cases, this ecotype represents the degraded form of Stable-Sensitive ecotypes that were formerly meadows. These ecotypes are comprised of down cut meadows with lowered water tables and abandoned flood planes. Meadow functions are not operating and vegetation is comprised of species that represent dry sites; accelerated erosion is common. A less common form of this ecotype is the altered form of the Naturally-Stable ecotype resulting from extensive accelerated sediment deposition on a coarse substrate. These areas exhibit braided characteristics the source of which is usually associated with upstream sites and/or deposition from off-site sources of sediment (roads, trails, campgrounds etc.) that has been transmitted to the site. Recovery usually requires active restoration measures. Figure 3, Tributary to Packsaddle is an example of a Naturally-Unstable-Degraded riparian ecotype.

Naturally-Unstable

This ecotype is typically eroded, steep, and unstable due to natural processes. It has a very high sediment load and is usually associated with debris avalanche or landslide terrain. These environments are sensitive to disturbance, and restoration is not practical due to a natural tendency for unstableness. Figure 4, Mill Creek is an example of a Naturally-Unstable riparian ecotype and is geomorphically described as a debris basin.

Description of Existing Conditions and Environmental Indicators for Riparian Ecotypes



Figure 4. Naturally Unstable Riparian Ecotype

This paper has described a process for grouping stream types that are expected to have a similar response to man induced disturbance, similar function, and a similar response to hydrologic events. The result of this grouping results in the defining riparian ecotypes. Assessing the health or existing condition of these ecotypes is the next step and requires an evaluation of environmental indicators appropriate for each ecotype.

Pfankuch, 1978 developed a channel stability procedure to systematically measure and evaluate the resistive capacity of mountain streams. The concept of riparian ecotypes had not been developed when Pfankuch envisioned his channel condition evaluation procedure. Since this time, selection of

environmental indicators appropriate for different channel types has been discussed in the literature and applied to stream surveys in the field. Five of the fifteen indicators used in Pfankuch are selected to evaluate the function of riparian ecotypes. The five indicators selected are those most affected by disturbance. These indicators are used to evaluate stream reaches that have been classified using Rosgen, 1985. Information from Rosgen, 1985; Meyers and Swanson, 1992; Forest stream inventory data from 1989 to present; and professional judgment has been used to determine which indicators are appropriate for each riparian ecotype.

The five riparian indicators used for evaluation of stream impacts and channel functions are: vegetative bank cover, stream bank cutting, channel bottom deposition, channel bottom scour and deposition, and percent stable material. The total sum of the indicators as described in Pfankuch is not employed in this system; rather the indicators are evaluated independently and then together to define a combination of processes responsible for changes in channel function. The 1994 South Creek Ecosystem Analysis provided a detailed investigation of the riparian ecotypes within the South Creek Basin. The analysis of environmental indicators for has proved useful in defining the existing condition and health of the channels.

Myers and Swanson, 1992 tested Pfankuch indicators for observer variation and the relationship between Rosgen stream type and damage to the riparian resources from ungulates. Vegetative bank protection and bottom size distribution and percent stable material were among the indicators with the least observer variation. Vegetative bank protection, cutting, and bottom size distribution and percent stable material are reported to have a high probability for varying with riparian damage as per Myers and Swanson, 1992. Deposition has a lower probability for varying with damage however it is applicable for use in Naturally-Stable and Unstable-Sensitive-Degraded riparian ecotypes. Table 1 displays probability of the five indicators to damage after Myers and Swanson, 1992. Deposition and scour & deposition are two different indicators. Because these are so closely related, they are shown together.

Table 1. Probability for variation of stream stability indicator with riparian damage after Myers and Swanson, 1992

Indicator <i>Channel Type</i>	Vegetative Bank Protection	Cutting	Deposition/ Scour & Deposition	Bottom Size Distribution and Percent Stable Material
<i>Naturally- Stable</i>	Low	Low	Moderate/High	High
<i>Stable-Sensitive</i>	High	High	Low/Low	Moderate

<i>Unstable-Sensitive-Degraded</i>	High	High	Moderate/Low	High
<i>Naturally-Unstable</i>	High	High	Low/Low	High

Myers and Swanson, 1992, question results of detecting scour and identifying deposition, especially in fine grained channels. However based on the predominately granitic channels of the Sequoia National Forest this indicator is considered appropriate for determining response to impact. Rosgen, 1994 evaluated the ability to predict response to management based on stream type. He indicates that the influence of vegetation on Naturally-Unstable riparian ecotypes is negligible. In conversations with Dr. Neil Sugahara, 1994, he states that these environments are generally occupied by invader species due to the unstable nature of the environment. Both of these views are contrary to Myers and Swanson, 1992. Therefore, based on Rosgen, Sugihara, and Forest evaluations, vegetative bank protection is not considered an appropriate indicator for Naturally-Unstable riparian ecotypes. There is agreement between Rosgen, 1994, and Myers and Swanson, 1992 as to the applicability of the other indicators in Table 1. The Forest data supports the use of these indicators to determine channel function and health. Although Myers and Swanson, 1992 do not support the use of scour and deposition, this indicator has been combined with deposition and is applicable for Sensitive-Unstable-Degraded and Stable-Sensitive riparian ecotypes of the predominately granitic Sequoia National Forest. The following is a description of the five indicators identified from Pfankuch's stream stability evaluation and the riparian ecotypes they are used to evaluate.

Vegetative Bank Cover

This indicator evaluates stream bank vegetation and root mat strength for bank stabilization and reduction of flood flow velocity. In addition, stem density, growth, and reproduction are estimated as important factors. Variety of plants and plant vigor is also considered. Vegetative bank cover is not applicable in Naturally-Stable ecotypes because boulder and bedrock controlled drainages are stable with or without vegetation. Nor is this indicator applicable in Naturally-Unstable ecotypes because vegetation is more a function of elevation and available water; furthermore, invader species are most common in these constantly changing unstable environments, (Sugihara, 1994, personal comm.).

Vegetative bank protection in Stable-Sensitive ecotypes is an excellent indicator to evaluate the condition of riparian areas and is sensitive to morphological changes that occur in meadows. All Stable-Sensitive ecotypes have the potential to achieve excellent or good conditions if left to heal in the absence of impacts. A Stable-Sensitive riparian ecotype in excellent vegetative condition would be expected to have 80-90% ground cover. Vegetation in lesser amounts has the potential to result in degradation to the less stable Unstable-Sensitive Degraded riparian ecotype.

Bank Vegetation for Unstable-Sensitive-Degraded ecotypes is generally composed of invader species along channel banks. The abandoned floodplain that generally exists at a higher elevation above these environments can be very well vegetated or could be devoid of riparian vegetation dependent on the availability and direction of subsurface water flow. These are usually sites of old meadows or existing

meadows with terraces that have been down-cut with the active channel working to re-establish a new floodplain and new equilibrium. Unstable-Sensitive Degraded riparian ecotypes, because of their often degraded nature when in “good” condition after Pfankuch, 1978, would have with 70% or greater ground cover with continuous stable root mass.

Bank Cutting

This indicator evaluates loss of aquatic vegetation by scour or uprooting. Where plants are naturally absent steepness of the channel bank is evaluated. Where roots bind upper bank soil surface horizon, undercutting is assessed as is overhanging sod and bank slump into the channel. Stream bank stability due to the loss of aquatic vegetation by high stream flows and bank cutting are inter-related. Bank cutting is not applicable in Naturally-Stable ecotypes because they are by definition rock controlled environments and very resistant. Bank cutting in ever changing, always eroding Naturally-Unstable ecotypes is not a good indicator of channel condition.

Bank cutting is an excellent indicator to evaluate changes in Stable-Sensitive ecotypes. A clear trend can be seen as channel types shift from E to C states along with an increase in width-to-depth ratios associated with bank cutting. E and C channel types are both meadow channels with slight entrenchment. E channels have a very low width-to-depth ratios and very high sinuosity while C channels have higher width-to-depth ratios and are less sinuous. The change in width-to-depth ratios from an E to a C is an indication of reduced channel stability and a reduction in channel health or condition. Stable-Sensitive ecotype in excellent condition has less than 20% of the banks affected by cuts greater than 1' high.

A Stable-Sensitive riparian ecotype undergoing a continued trend of cutting will result in Unstable-Sensitive-Degraded ecotype more commonly known as a gully. This trend can be reversed in Stable-Sensitive riparian ecotypes by removal of the disturbance. Unstable-Sensitive-Degraded riparian ecotypes in fair condition should not have more than 30% of the reach comprised of cut banks of 1' or higher. It is common for channels in this ecotype to have near vertical raw banks that exceed two feet high and root mat overhangs.

Channel Bottom Deposition, and Scour & Deposition

Deposition, and scour and deposition are based on the amount of sand and gravel bar development in areas where they did not previously exist. Increases in sediment accompany increases in width-to-depth ratios, increased surface water slope, increase velocity, decrease of channel sinuosity and an increased channel bar and bench formation. Channel bottom deposition and scour & deposition are not applicable indicators for Naturally-Unstable ecotypes because their channel bottoms are always in a state of deposition and flux. The channel is usually so steep and void of pools in this ecotype that that

there is no place for sediment to deposit. Furthermore there is so much loose debris it would be impossible to quantify changes in response to disturbance.

Deposition and scour and deposition are the only indicators applicable to Naturally-Stable riparian ecotypes. The presence of deposition and sediment movement in this ecotype is an indication of transport from upstream or off-site sources. Management actions that have the potential to affect this indicator are reduction in sediment from off-site sources. In watersheds void of Naturally-Unstable and Unstable-Sensitive-Degraded riparian ecotypes, this indicator would evaluate the effectiveness of water quality and soil conservation measures. Naturally Stable ecotypes in good condition have a low frequency of mid channel bars, good pool to riffle ratios and no more than 5-30% of the bottom affected by sand and gravel bar deposition.

Scour and deposition is not appropriate in Stable-Sensitive ecotypes due to the ever-changing depositional nature of these environments; however scour and deposition is not to be confused with deposition, which is an excellent indicator in these meadow environments. Deposition in Stable-Sensitive channel types show trends similar to other indicators in this environment. As deposition increase in Stable-Sensitive ecotypes channel types can be seen to trend toward a more unstable state. Once the boundary conditions or threshold for sediment deposition is exceeded these ecotypes will trend toward the Unstable-Sensitive-Degraded riparian ecotypes. Stable-Sensitive ecotypes in excellent condition have little or no sand bar development with less than 5% of the bottom affected by deposition of sand and gravel bars.

Unstable-Sensitive-Degraded ecotypes show a shift toward enlarging mid-channel sand and gravel bars, filled pools, and fish habitat comprised predominately of riffles with little pool development. The indicators of deposition and scour and deposition, like in Naturally-Stable ecotypes, are evaluated together and evaluate the amount of sand and gravel that accumulates in sand bars, behind logs, and narrow stream reaches. Unstable-Sensitive-Degraded riparian ecotypes in good condition have between 5-30% of the channel affected by bar development from deposition.

Bottom Size Distribution and Percent Stable Material

Bottom size distribution and percent stable material is based on the normal distribution of stable material (rock) of a given channel type. As pools become filled with sediment an increase of fine material becomes the predominate size class and stable material becomes less abundant.

This indicator is not applicable for Naturally-Stable riparian ecotypes because on-site impacts do not alter the natural stability of these systems, as they are comprised of stable material by definition. If sedimentation increases to the point where a shift in size classification is significant these ecotypes have probably become braided systems and shift into the Unstable-Sensitive-Degraded riparian ecotype. This indicator is also not applicable for Stable-Sensitive riparian ecotypes because these are predominately depositional fine-grained systems and would not show a “distribution shift.” This indicator is also very hard to evaluate in Naturally-Unstable ecotypes because of the random distribution of landslide and debris avalanche deposits.

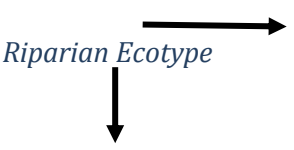
This indicator is appropriate for evaluation of Unstable-Sensitive-Degraded riparian ecotypes. Based on observed forest conditions most of these ecotypes have a moderate shift from stable material. An Unstable-Sensitive-Degraded riparian ecotype in good condition would have a slight distribution shift where stable material would comprise between 50 to 80% of the existing substrate.

Environmental indicators are important for the evaluation of the condition of riparian ecotypes and play an important part in monitoring to determine if changes are occurring within the hydrologic zone of influence. As discussed above, not all indicators are appropriate for all ecotypes. Table 2 displays those environmental indicators that are associated with the riparian ecotypes. With the exception of Stable-Sensitive riparian ecotypes, indicators specific to an ecotype have a description of the conditions that Pfankuch, 1978, uses in describing a channel in “good” condition in the column below the appropriate indicator. Stable-Sensitive riparian ecotypes have ratings of excellent.

Application of Environmental Indicators to Determine Channel Condition

Channels that have been channel typed after Rosgen, 1985, and evaluated for channel stability after Pfankuch, 1978 have the field data necessary for determination of condition, health, level of impact, or any other term that suggests evaluation of function. Initially the channels need to be grouped into their appropriate riparian ecotype. Environmental indicators appropriate for the riparian ecotype then need to be assessed to determine the Pfankuch condition rating. In most cases, the division between a rating of fair and good is the boundary condition or threshold used to assess health or condition. This boundary condition is stricter for all indicators in meadow (Stable-Sensitive ecotypes) due to the significant role vegetation, cutting, and deposition play in these environments. The division between good and excellent is used as the boundary condition for all environmental indicators in Stable-Sensitive riparian ecotypes.

Table 2. Conditions for the various indicators appropriate for specific riparian ecotypes and their boundary conditions for a condition rating of “Good” after Pfankuch 1976.

Environmental Indicator				
 <i>Riparian Ecotype</i>	Vegetative Bank Protection	Bank Cutting	Bottom Deposition and Scour& Deposition	Bottom Size Distribution and % Stable Material

<i>Naturally Stable</i> Rosgen Channel Type: A1, A2, B1, B2, B3, C1, C2, F1, F2, G1, G2 Restoration Not Required	NA	NA	Low frequency of mid-channel bars and good pool to riffle ratio	NA
<i>Stable Sensitive</i> Rosgen Channel Type: B4, B5, B6, C3, C4, C5, C6, E3, E4, E5, E6 <u>Recover with Passive Restoration</u>	80 to 90 % ground cover with stable continuous root mass	Less than or equal to 1 foot of exposed bank cuts affecting less than or equal to 20% of the channel	Little or no sand bar development with 0 to 5% of the bottom affected by bar deposition	NA
<u>Unstable-Sensitive Degraded</u> Rosgen Channel Type: G2, G3, G4, G5, G6, F3, F4, F5, F6, and those D3, D4, D5, D6 in unexpected geomorphic settings. <u>Recover with Active Restoration</u>	Greater than or equal to 70 % ground cover with stable continuous root mass	Less than or equal to 1 foot of exposed bank cuts affecting less than or equal to 30% of the channel	Low frequency of mid channel bar development, Improved pool to riffle ratio, with 5 to 30% deposition behind obstructions	Slight size distribution shift between 50-80% stable material
<u>Naturally Unstable</u> Rosgen Channel Type: A3, A4, A5, A6 (Landslide and Debris slide Terrain) Impractical to Restore	NA	NA	NA	NA

The condition of a riparian ecotype is based on how many environmental indicators exceed the boundary condition or threshold for the indicators applicable to the ecotype. Table 3 displays the relationship between the assigned level of impact or condition rating and the number of environmental indicators exceeding threshold or boundary conditions for a functioning ecotype. Ecotypes with fewer environmental indicators will not reach impact levels greater than the rating assigned to the number of available environmental indicators.

Number of Environmental Indicators Exceeding Boundary Conditions or	Level of Impact or Condition
---	------------------------------

Threshold	Rating
0	Minimal
1	Low
2	Moderate
3	Moderate-High
4	High
5	Extreme

Table 3. Number of environmental indicators and condition rating for riparian ecotypes

Riparian ecotypes such as Stable-Sensitive and Naturally-Stable contain three or one environmental indicator(s) and therefore cannot exceed an impact level of moderate-high or low, respectively. Given the tendency for Stable-Sensitive environments to change to Unstable-Sensitive-Degraded environments if vegetation, cutting, and deposition occur, it is intuitive that meadow environments cannot exceed moderate high impact levels and still function as a meadow. Conversely, unless a Naturally-Stable environment has a tremendous amount of sediment deposited and shifts in character to a Naturally-Unstable-Degraded braided system, it will maintain it's stable nature and will recover once the source of sediment is stabilized or restored.

References Cited

- Myers, T.J. and Swanson, Sherman, 1992, Variation of stream stability with stream type and livestock bank damage in Northern Nevada. Water Resources Bull. AWRA, 28(4): 459-486.
- Pfankuch, Dale, J. 1978. Stream Reach Inventory and Channel Stability
- Evaluation: A Watershed Management Procedure. Unpublished Report, USDA Forest Service, Northern Region, 22 pages.
- Rosgen, D.L. 1985. A stream classification system. In: Riparian ecosystems and their management. First North American Riparian Conference. Rocky Mountain Forest and Range Experiment Station, RM-120, pp. 91-95.
- Rosgen, D.L. 1994. A classification of natural rivers. Catena 22 (1994) 169-199.
- Rosgen, D.L., 1996, Applied River Morphology, Wildland Hydrology, Pagosa Springs, Colorado.
- USDA, Forest, Sequoia National Forest, 1994, South Creek Ecosystem Analysis, Hot Springs Ranger District.

Appendix B: Erosion Control Plan

The objective of this BMP is to effectively limit and mitigate erosion and sedimentation from any ground-disturbing activities, through planning prior to commencement of project activity, and through project management and administration during project implementation.

As the project includes riparian areas greater than 50 square feet an erosion control plan is required for this project.

List of anticipated ground-disturbing actions associated with the project.

No mechanical ground disturbing activities are proposed as part of the Boulder Burn Project. Ground-disturbing activities would include the use of a helicopter to drop plastic sphere dispensers (PSD) as the firing agent. Other areas would be lit by hand. (Such as drip torch) After the prescribed burn treatments, hand crews would repair trail tread if the burning activities damaged the trail (i.e., Kanawyer Trail). The treadwork may include reestablishing waterbars or other drainage features along the trail. These activities would be designed to reduce the potential for erosion or sedimentation as a result of the fuels reduction activities, and manage that portion of trail to standard. No mechanical treatments or removal of logs or other forest products is proposed under this project.

Checklist which includes mitigation measures required by project NEPA, requirements to meet BMPs, project plans, specifications, and permits, if any. The selection of erosion and sedimentation control measures shall be based on assessments of site conditions and how storm events may contribute to erosion.

Specific mitigation's are included in the cumulative watershed effects within this document. Site conditions and the potential for erosion are also included within the CWE analysis of this document. The EA also describes the BMP effectiveness monitoring.

Illustrations of control practices designed to prevent erosion and sedimentation. Illustrations must show construction and installation details for control practices, and must be included in the erosion control plan. (for example, California Stormwater Quality Association BMP standard specifications CASQA at <http://www.cabmphandbooks.com>, or Caltrans Stormwater and Water Pollution Control guides at <http://www.dot.ca.gov/hq/construc/stormwater/stormwater1.htm>)

Constructed erosion control measures are determined to not be needed as part of this project.

Map/drawing(s) showing soil or water buffer zones, RCAs, RCHAs, SMZs or other soil or water protection areas to be protected from project activities. Project boundary extends beyond disturbance limits. A description of the color and/or pattern of flagging or marking for soil or water buffer zones, RCAs, RCHAs, SMZs or other soil or water protection areas for each unit.

This requirement is not applicable for this project. Fire may be allowed to back into riparian areas, but is expected to be low fire intensity.

Relevant sections from the forest's WWOS that apply to activity/activities. The WWOS will provide guidance to prevent significant adverse impacts to water quality from wet weather operations on NFTS roads and trails.

Wet weather operations are not anticipated to be needed as part of the Boulder Project.

i. Forest motor vehicle use map will be used to determine seasonal closures for all NFTS routes that are not under permit or for administrative use only.

NA

(1) A storm preparedness plan that describes additional control practices to be implemented when the National Weather Service predicts a 50 percent or greater chance of precipitation.

NA

(2) A winterization plan that describes additional control practices to be implemented to stabilize the site during periods of seasonal inactivity. The dates vary by locality, and may be determined by the individual RWQCB (for example, October 15 through May 1). "Winterized" means that the site is stabilized to prevent soil movement permanently if project activities are complete, or temporarily in a manner which will remain effective until end of the stabilization period.

After the prescribed burn treatments, hand crews would repair trail tread if the burning activities damaged the trail (i.e., Kanawyer Trail). The treadwork may include reestablishing waterbars or other drainage features along the trail. These activities would be designed to reduce the potential for erosion or sedimentation as a result of the fuels reduction activities, and manage that portion of trail to standard.

(3) If winter activity, including over-snow operation is proposed, specifications for snow/ice depth or soil operability conditions must be described.

NA

Control practices to reduce the tracking of sediment onto paved roads. These roads will be inspected and cleaned as necessary.

NA

Control practices to reduce wind erosion and control dust.

Excessive road traffic isn't expected as part of the proposed action, when wind and dust control is needed roads would be watered.

A proposed sequential schedule to implement erosion and sediment control measures, in addition to the general construction schedule.

Schedule for proposed action can be found in the Environmental Assessment for the Boulder Project, post-fire BMP effectiveness will determine if erosion and sediment control measures are needed. It is not anticipated that erosion and sediment control measures are needed.

j. Location information, including directions to access the project area. Include a scaled map, with road names/numbers.

Map included within document and environmental assessment.

k. Contact information of project personnel, including name and cell phone number (that is, sale administrator, contracting officer's representative, project manager, project supervisor, contractor, site superintendent, hydrologist, permit administrator and so forth)

All relevant contact information will be located within the burn plan prior to any activities.

2. Maps requirements: Maps must be clear, legible, and of a scale such that depicted features are readily discernible. For example, sale area maps may be used to satisfy the mapping requirements outlined in b.ii, below, if they meet this intent.

a. As a means of determining BMPs and erosion control measures, a topographic map should be in the project file. The map should extend beyond the boundaries of the project site, showing the project site boundaries, and surface and subsurface water bodies (ephemeral and intermittent waters, springs, wells, and wetlands) that could be at risk of water-quality impacts from project activities.

Topographic maps are included in this report. (Watershed Specialist Report)

b. For timber harvest activities, unit-specific map(s) shall be scaled no smaller than 1 inch equals 1,000 feet (1:12,000). For all other activities, maps shall be scaled to provide legible interpretation of requirements shown above. All maps shall include:

(1) Specific locations of storm water structures and controls used during project activities.

NA

(2) Erosion hazard ratings for each unit, specified down to 20 acres if different EHRs exist within each unit.

NA

(3) Locations of existing and proposed haul roads, watercourse crossings, skid trails, and landings.

NA

(4) Locations of post-project storm water structures and controls.

NA

(5) Equipment access, storage, and service areas.

NA

3. Diversion of Live Streams: If the project involves stream diversions for crossing construction, the erosion control plan must include detailed plans for these activities, including storm contingencies. See BMP 2.8 - Stream Crossings.

NA

4. Non-Storm Water Management: The erosion control plan shall include provisions which eliminate or reduce the discharge of materials other than storm water to the storm sewer system and/or receiving waters. Such provisions shall ensure that discharged materials shall not have an adverse effect on receiving waters. Materials other than storm water that are discharged shall be listed, along with the estimated quantity of the discharged material.

NA

5. Waste Management and Disposal: The erosion control plan shall describe waste management and disposal practices to be used at the project site. All wastes (including equipment and maintenance waste) removed from the site for disposal shall be disposed of in a manner that is in compliance with Federal, State, and local laws, regulations, and ordinances. Include plan for project-specific activities that produce waste products, such as concrete truck/chute/pump washout, equipment servicing, equipment washing, and so forth.

NA

6. Maintenance, Inspection, and Repair: The erosion control plan shall include inspection, maintenance and repair procedures to ensure that all pollution-control devices identified in the erosion control plan are maintained in good and effective condition and are promptly repaired or restored. A qualified person shall be assigned the responsibility to conduct inspections. The name and telephone number of that person shall be listed in the erosion control plan. A tracking and follow-up procedure shall be described to ensure that all inspections are done by trained personnel and that adequate response and corrective actions have been taken in response to the inspection. This procedure may be in the form of a written checklist, with inspections signed and dated. Photo documentation is encouraged.

NA

7. Other Plans: This erosion control plan may incorporate, by reference, the appropriate elements of other plans required by local, State, or Federal agencies. A copy of any requirements incorporated by reference shall be kept in the project file.

This plan will potentially be incorporated into the Burn Plan for the Boulder Burn.

8. Post-Project Storm Water Management: The erosion control plan shall describe the storm water control structures and management practices that will be implemented to minimize pollutants in storm water discharges after project activity phases have been completed at the site. It shall also specify controls to be removed from the activity site(s) and methods for their removal. The discharger must consider site-specific factors and seasonal conditions when designing the control practices that will function after the project is complete.

NA

9. Preparer: The erosion control plan shall include the title and signature of the person responsible for preparation of the erosion control plan, the date of initial preparation, and the person and date responsible for any amendments to the erosion control plan.

Prepared by: Date: 10/24/12
Kyle E. Wright, Hydrologist
Sequoia National Forest and Giant Sequoia National Monument

Responsible for Amendments: Date: 10/24/12
Kyle E. Wright, Hydrologist
Sequoia National Forest and Giant Sequoia National Monument